

NO. 27.5 AC-8.5 THEORY OF OPERATION

The AC-8.5 PC Assembly contains buffer and voltage gain circuitry for the No. 27.5 Power Amplifier. Regulated DC Supplies and current gain circuitry are located on the AC-8 PC Assembly and interconnected via gold pins.

BUFFER STAGE ONE

The buffer input stage consists of a bipolar cascoded differential amplifier with passive collector loading and constant current source and sink for DC biasing. Q50, Q52 and R62 comprise a current sink for total first stage current of 2.4 mA. 800 μ A is available to each half of Q64, a supermatch pair configured as a differential common emitter amplifier. The remaining 800 μ A is sourced by Q62, Q63 and R55 for biasing of cascoded common base amplifiers Q51 and Q53 by CR68, CR69 and R61.

BUFFER STAGE TWO

The second buffer stage is comprised of a differential input amplifier, Q55 and Q59, with current mirror Q56 and Q58, for conversion to single-ended output. Half of the differential amplifier is cascoded by Q57 for isolation from driveline voltage swings. Passive DC biasing is accomplished by R75, R76 and R77. Approximately 9 mA is available to each side of the differential amplifier, with 1 mA bias through R76 and R77 to set DC bias of Q57's base.

BUFFER OUTPUT STAGE

The buffer output stage is comprised of a complimentary emitter follower configuration of Q60 and Q61, whose emitter currents are set at approximately 12 mA by bias elements CR62, CR63 and R80.

VOLTAGE GAIN STAGE ONE

The voltage gain input stage consists of a bipolar cascoded differential amplifier with passive collector loading and constant current source and sink for DC biasing. Q2, Q3, R13 and R14 comprise a current sink for total first stage current of 3.2 mA. 800 μ A is available to each half of Q19, a supermatch pair configured as a differential common emitter amplifier. The remaining 1.6mA is sourced by Q4, Q5, R12 and R38 for biasing of cascoded common base amplifier Q1 by CR1, CR2 and R10, and Q6 by CR3, CR4 and R16.

VOLTAGE GAIN STAGE TWO

The second voltage gain stage is comprised of a differential common emitter amplifier Q9 and Q18, cascoded common base amplifiers Q10 and Q15, with current mirror Q11 and Q17, for conversion to single-ended output. Current mirror element Q17 is cascoded with Q16 as are their circuit complements, Q18 with Q15, for isolation from driveline voltage swing. Q13 provides bias for Q16 and, in conjunction with CR27 and CR28, for Q11 and Q17. CR19 provides a constant current load for Q13 to ensure that it never turns off.

Second stage current source Q12, Q14 and R29 provides 57.5mA, approximately 24mA to each side of the differential amplifier, and the remaining 10 mA through cascode bias chains CR13-CR18 and CR20-CR25 and current sink Q7, Q8 and R24.

NO. 27.5 AC-8 THEORY OF OPERATION

REGULATOR

Voltage gain stages are powered by regulated + and - 65V supplies. DC rectification is performed by a discrete full-wave bridge located on the VB-5 PC board. Two 1900 μ F capacitors clamped to the chassis provide filtering before the unregulated voltages are brought to the channel's two separate, non-tracking regulators. Since the regulators are complimentary but identical in operation, only the positive regulator will be described in detail.

A reference voltage is set by 36V Zener diode CR206, and filtered by R207, C201 and C203. Zener current is available on power-up through R229 and CR211; as regulated output stabilizes, CR211 is reversed biased, CR203 becomes forward biased, and CR204 provides a regulated current for Zener operation. A differential amplifier comprised of Q201 and Q203 compares Zener reference to a portion of regulator output. Regulator gain $\{1 + (R225 + R215a)/(R215b + R219)\}$ can be adjusted by varying R215. Voltage gain is provided by common emitter amplifier Q205, and current gain by emitter followers Q207 and Q209 for the required +65V, 132mA output.

ANTI-THUMP

During turn-on and turn-off, transients are minimized by clamping amplifier drive lines to ground. Clamping, comparator and timing circuitry is located on the AC-8 PC assembly.

1. COMPARATOR

Comparator Q213 monitors -VReg and develops the appropriate voltage across its collector load resistor, R240, to control clamping action. With Q213's base held to -12V by CR220, CR222 in Zener breakdown at 47V, and voltage across R244 setting emitter current, Q213 remains in saturation during normal amplifier operation. If -VReg falls below the Zener threshold of CR220 + CR222, emitter current through R244 ceases and voltage across R240 falls to zero.

Q214, an N-Channel J-FET, is switched by Q213 to control the voltage at the junction of R239 and R241. During normal operation, Q214's gate voltage is held at -12V, well below specified gate-source cutoff voltage. Drain current at this time is virtually zero. Diode CR219 is in Zener breakdown and voltage at the junction of R238 and R239 is approximately 12V. When Q213 is not conducting (at turn-on or after turn-off), Q214's gate voltage fall to 0V, Q214 saturates, and the junction of R238 and R239 is brought to ground.

2. TIMING

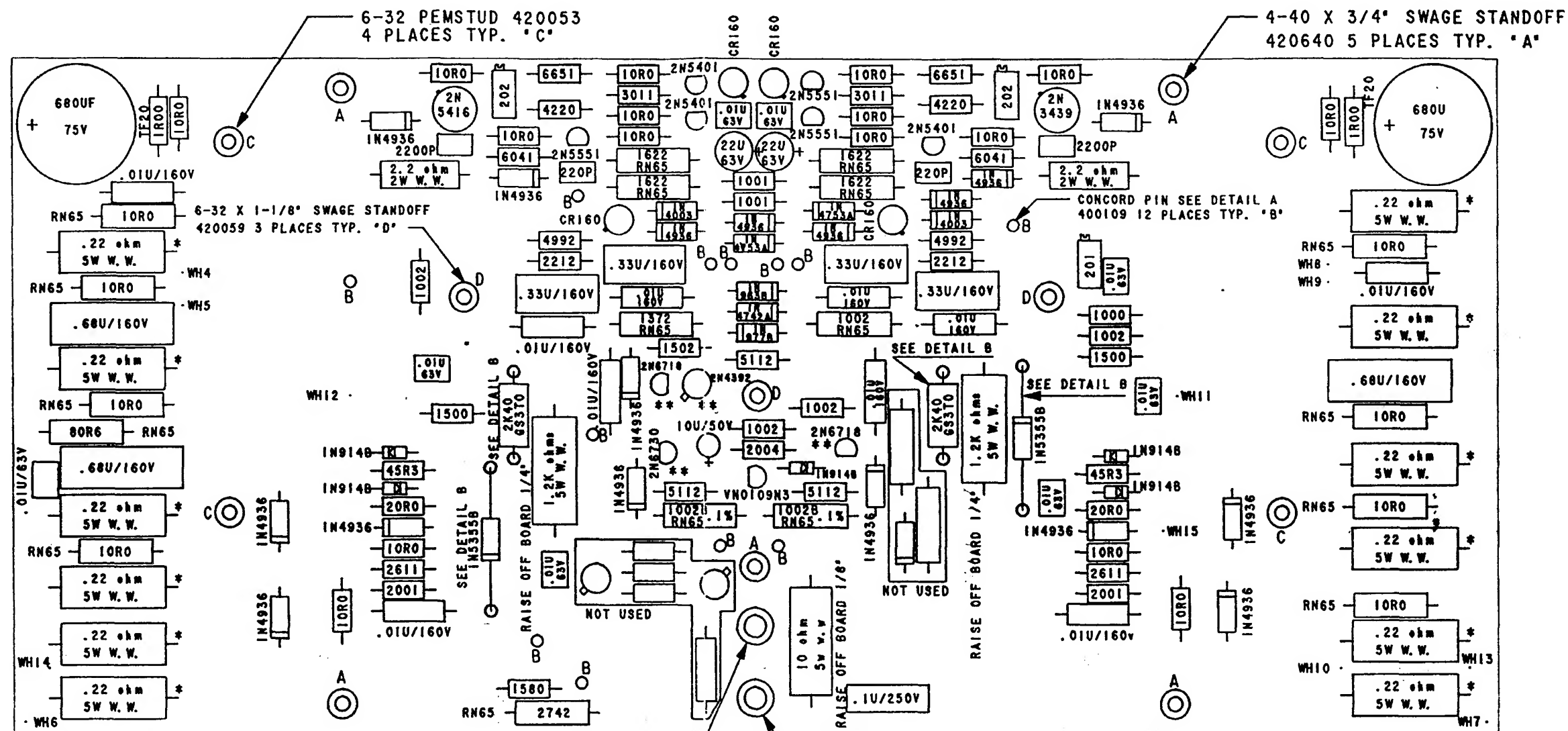
C213 will always charge to the voltage at the junction of R239 and R241. When Q214 is in cutoff (after turn-on and during normal amplifier operation), C213 charges slowly through R239, R241 and R242 to +12V. When Q214 saturates (at turn-on or after turn-off), C213 discharges quickly through CR223, R241 and the drain of Q214 to ground. Charge on C213 is applied to the gate of MOSFET Q216.

3. CLAMPING

Amplifier drive lines are clamped to ground during power-up and power-down by saturated bipolar transistors Q215 and Q217 and their associated steering diodes CR224 and CR225. Saturation of these transistors is controlled by Q216. When the charge on C213 is near 0V, Q216, an enhancement-mode device, does not conduct, and bases of Q215 and Q217 are biased heavily through R245 and R246. As C213 charges toward +12V, Q216 conducts heavily, shorting the bases of Q215 and Q217 together and diverting base current through its channel. With Q215 and Q217 now off, collector-diode junctions are pulled to power supply rails to prevent interference with drivelines during normal operation.

SOFT CLIP

Voltage limiting of drive lines is performed by Q115 and Q116. Base voltages for these devices are established by the resistor divider network of R131-R130-R132. Emitter current for Q115 and Q116 is set by R133 and R134. As unregulated rails sag due to current demands of the load, these voltages will adjust accordingly. When drive lines exceed these predetermined voltages, CR101, CR102 and CR103 or CR104, CR105 and CR106 will begin to conduct. Multiple breakpoints set by these diodes shape the limited drivelines before hard saturation of second stage, drivers or outputs can occur. Harsh diode turn-on characteristics are softened by parallel resistors R137, R139, R138 and R140. Soft clip circuitry is the primary limiting circuit when driving loads as low as two ohms.



10-32 X 7/16" SWAGE STANDOFF 420052J 10-32 X 3/16" SWAGE STANDOFF 420051J

CR217, CR218-IN5355B
OR
R251, R252-2K40/GS3T0
SPACER 3 PER LEAD
400028

DETAIL B
SPACER MOUNTING

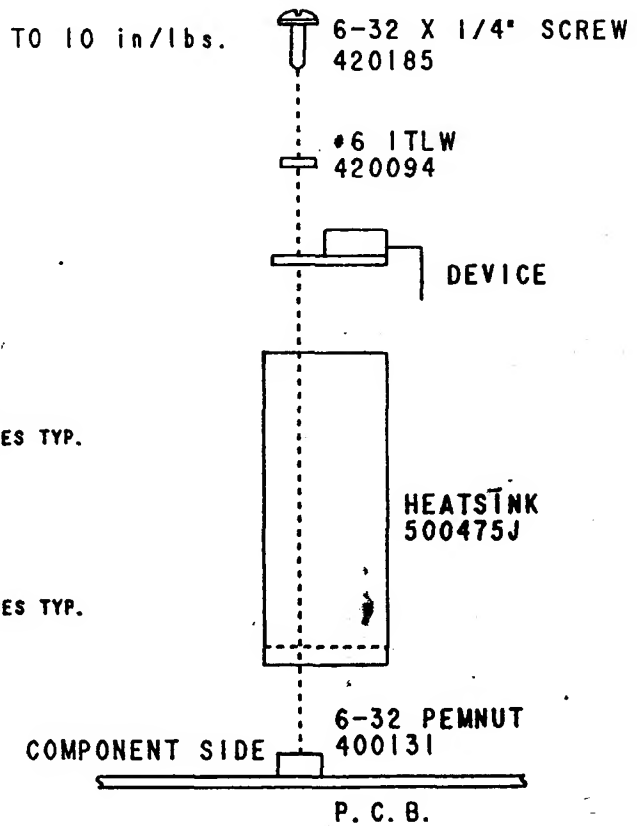
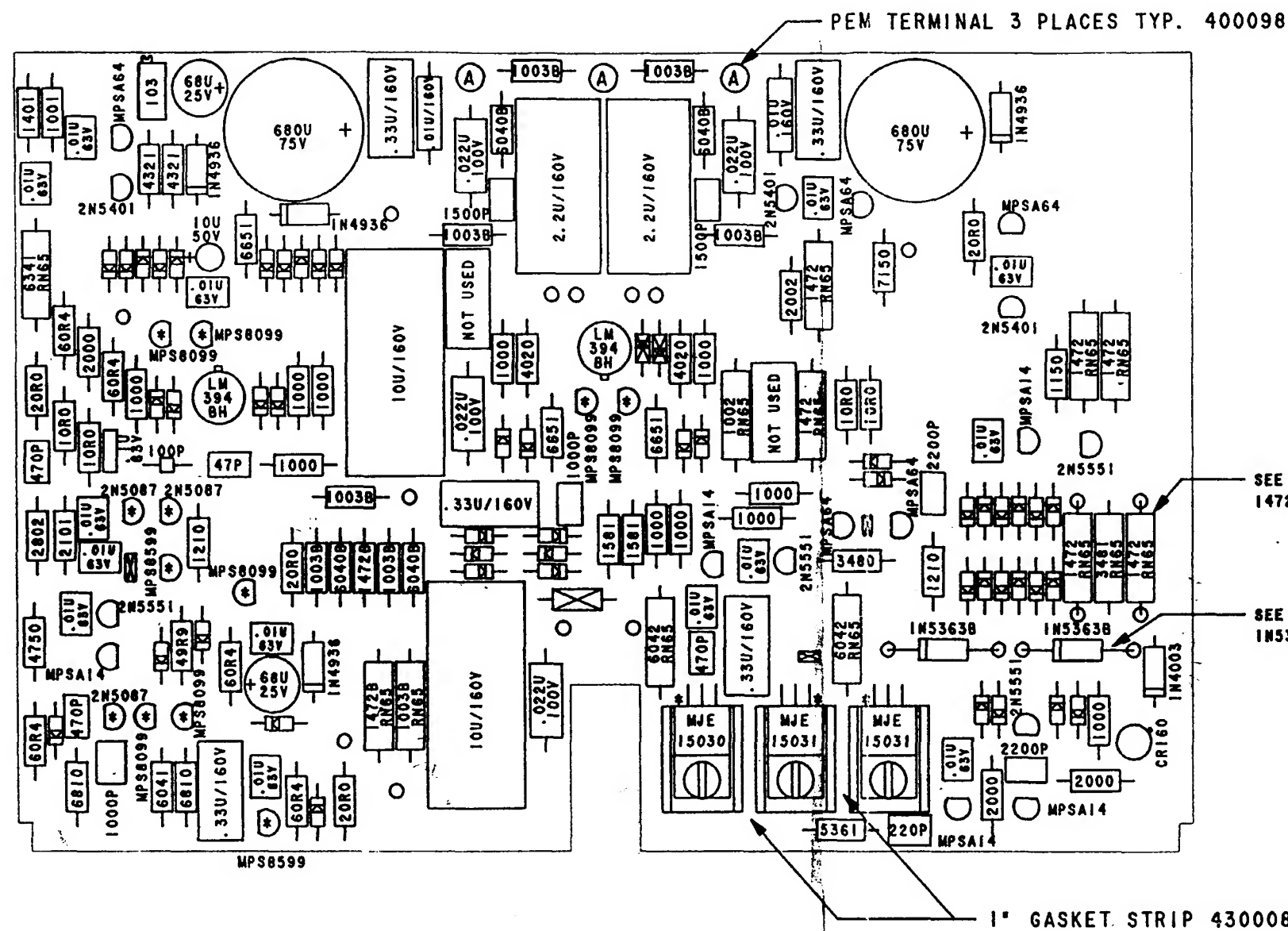
CONCORD PIN
400109
COMPONENT SIDE

DETAIL A
CONCORD PIN MOUNTING

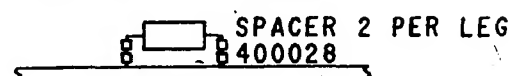
* RAISE OFF BOARD 1/8"
** SORTED TRANSISTORS
NOTE:
1 ALL RESISTORS ARE RN60D UNLESS OTHERWISE SPECIFIED.

ORIGINAL IN RED	
Part No.	580185A
OR	940779
Release date:	
Type of release:	<input checked="" type="checkbox"/> Prototype <input type="checkbox"/> 1st production <input type="checkbox"/> Pilot <input type="checkbox"/> Revision
Comments:	
Drafting approval: <i>G.A.</i> Engineering approval: <i>MM</i> Issued by: <i>Daryl Bradley</i> Date: <i>3-29-92</i>	

TOLERANCES UNLESS SPECIFIED				MADRIGAL audio_laboratories, inc.			
FRACTION $\pm .010$				2081 south main street middletown connecticut 06457 u.s.a.			
DECIMAL $\pm .005$				MATERIAL			
ANGLE $\pm 1/2^\circ$				SHEET OF SIZE			
DR. BY DATE				A B C D E R			
CH. BY DATE				USED IN			
ISSUE				No. 27.5			
REVISION				NAME			
DATE				AC-8 ASS'Y DWG NOCODE			
SCALE				NO. 940779			



PLACE SPACERS ON
CR9, CR10 IN5363B
R28, R30 1472 RN60

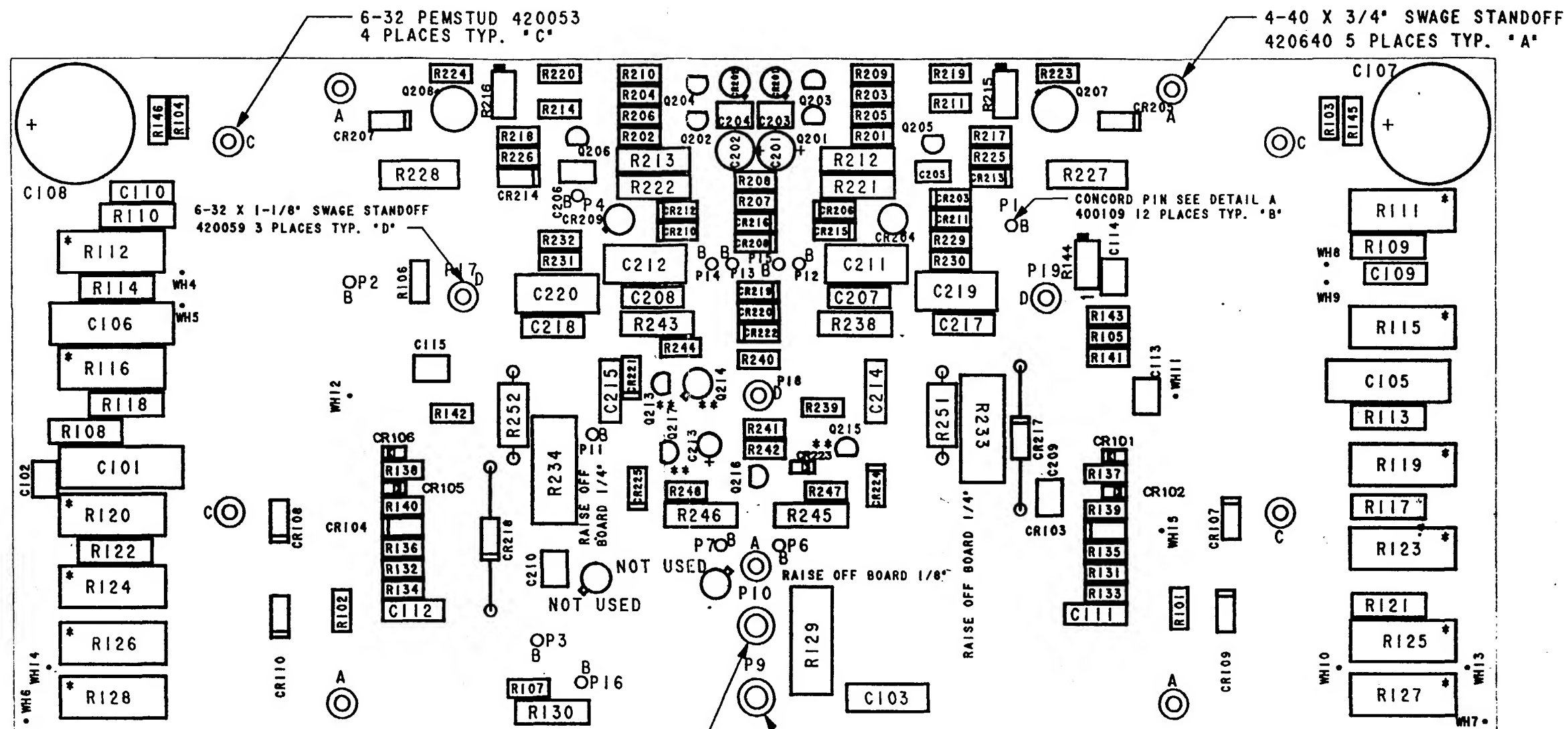


P. C. B.

DETAIL B

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<input type="checkbox"/> 1st production <input type="checkbox"/> Revision	
Comments	
Drafting approval: <i>[Signature]</i> Engineering approval: <i>[Signature]</i>	
Issued by: <i>[Signature]</i> Date: 3-24-92	

TOLERANCES UNLESS SPECIFIED			MADRIGAL audio_laboratories, inc.		
FRACTION $\pm .010$			2081 south main street middletown connecticut 06457 u.s.a.		
DECIMAL $\pm .005$			MATERIAL		
ANGLE $\pm 1/2^\circ$			SHEET OF SIZE B		
DR. BY DATE			USED IN		
CH. BY DATE			No. 27.5		
ISSUE			NAME		
REVISION			AC-8.5 ASS'Y DWG NOCODE		
DATE			NO.		
SCALE			940782		



10-32 X 7/16" SWAGE STANDOFF 420052J 10-32 X 3/16" SWAGE STANDOFF 420051J

CR217, CR218-1N5355B
OR
R251, R252-2K40/GS3T0
SPACER 3 PER LEAD
400028

DETAIL B
SPACER MOUNTING

CONCORD PIN
400109
COMPONENT SIDE

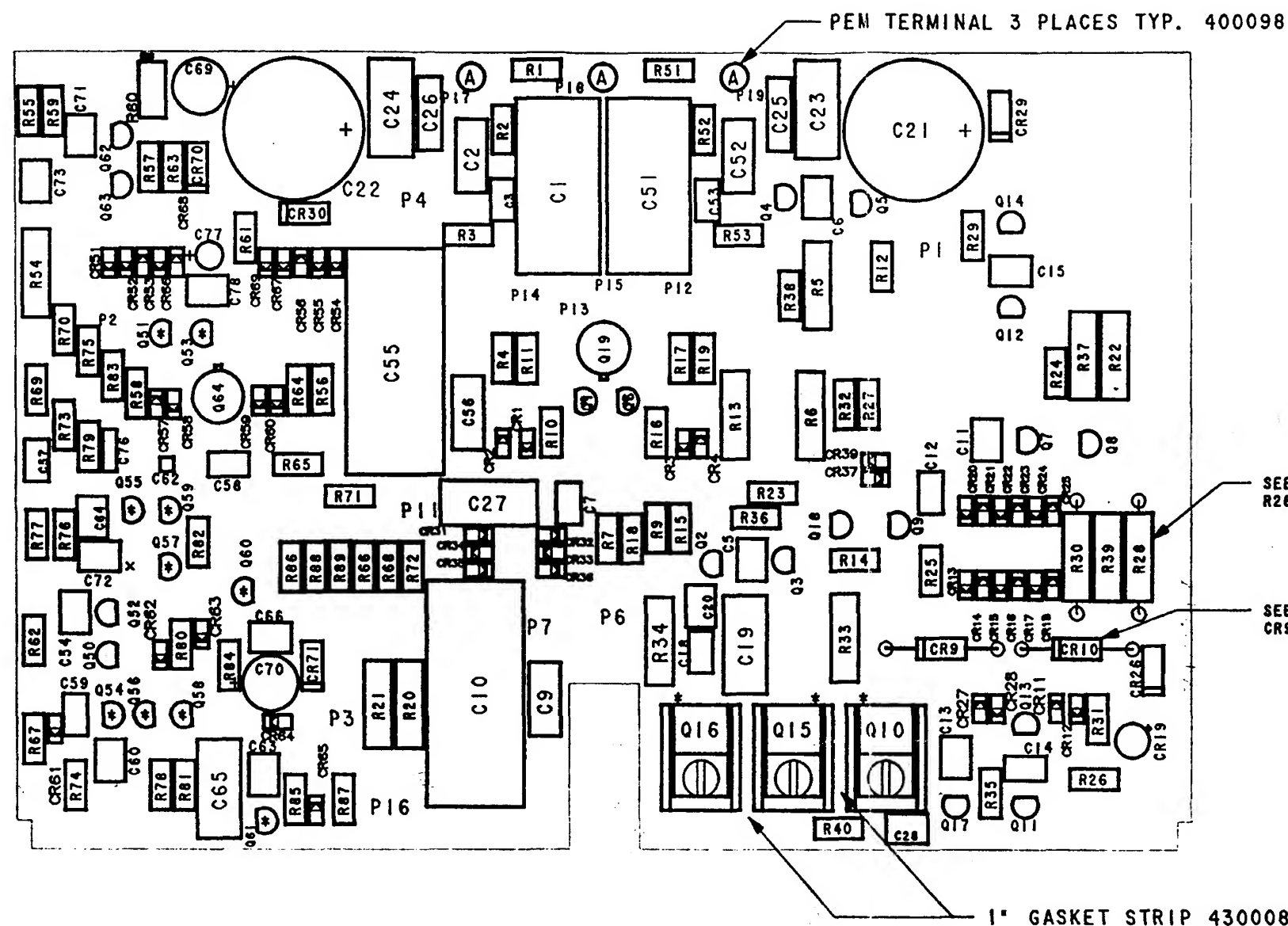
DETAIL A
CONCORD PIN MOUNTING

* RAISE OFF BOARD 1/8"
** SORTED TRANSISTORS

NOTE:
1 ALL RESISTORS ARE RN60D UNLESS OTHERWISE SPECIFIED.

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OR	
Print No.	940778A
Release date:	
Type of release:	<input checked="" type="checkbox"/> Prototype <input checked="" type="checkbox"/> Pilot
	<input type="checkbox"/> 1st production <input type="checkbox"/> Revision
Comments:	
Drafting approval: <i>G.A.</i> Engineering approval: <i>MM</i>	
Issued by: <i>Dwight Bradley</i> Date: <i>7-29-92</i>	

TOLERANCES UNLESS SPECIFIED				MADRIGAL audio_laboratories, inc.			
FRACTION $\pm .010$				2081 south main street middletown connecticut 06457 u.s.a.			
DECIMAL $\pm .005$				MATERIAL		SHEET	OF
ANGLE $\pm 1/2^\circ$				USED IN No. 27.5		A	B
DR. BY DATE				NAME		C	D
CH. BY DATE				AC-8 ASS'Y DWG		E	R
A CIRCUIT CHANGED 12-9				NO.		940778A	
ISSUE REVISION DATE SCALE							



TORQUE TO 10 in/lbs.

6-32 X 1/4" SCREW
420185

#6 ITLW
420094

DEVICE

HEATSINK
500475J

6-32 PEMNUT
400131
P. C. B.

DETAIL A

* MATCHED PART
ALL DIODES ARE 1N914B UNLESS OTHERWISE SPECIFIED.

PLACE SPACERS ON
CR9, CR10 1N5363B
R28, R30 1472 RN60

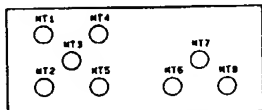
SPACER 2 PER LEG
400028

P. C. B.

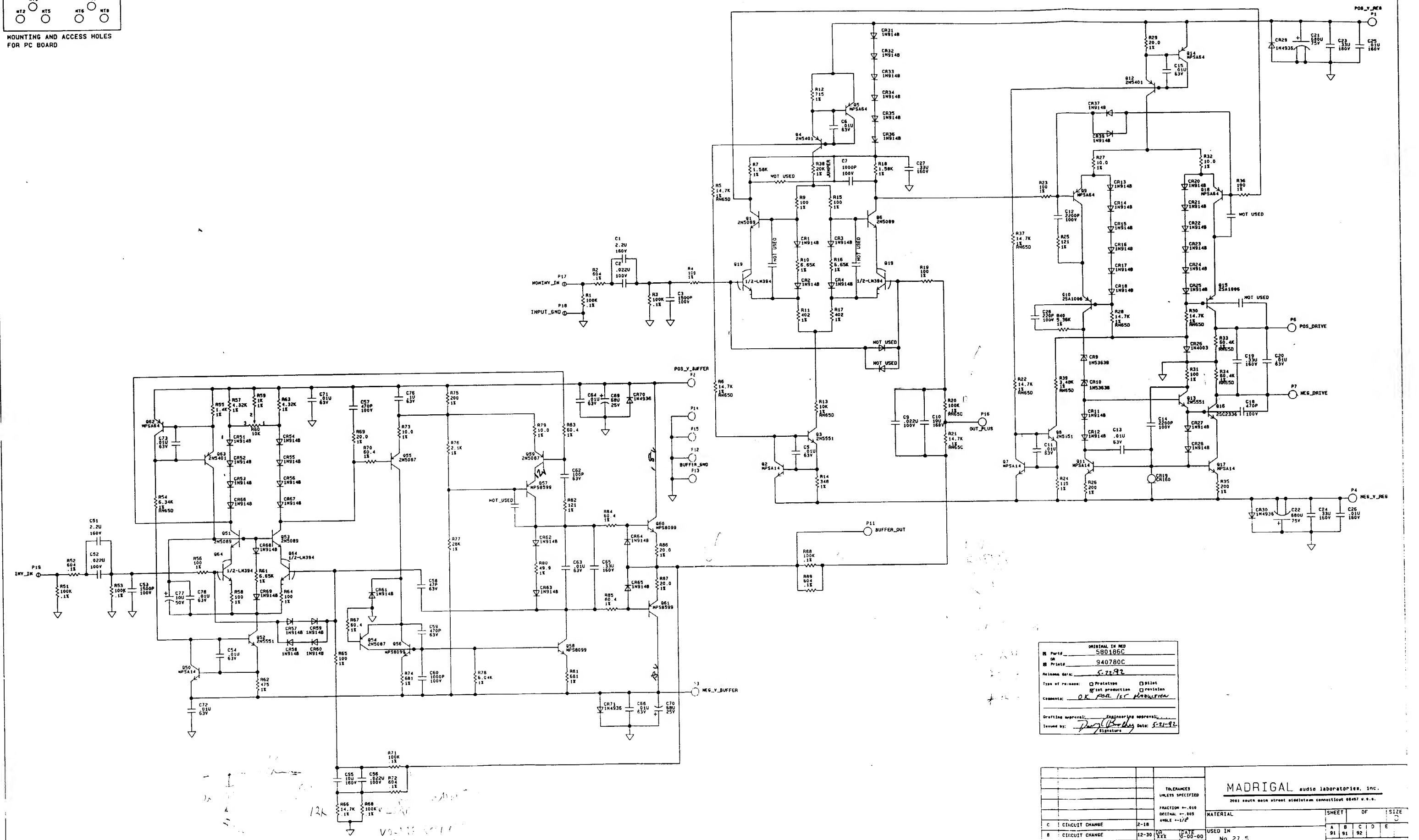
DETAIL B

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Print No.	940781C
Release date	
Type of release	<input checked="" type="checkbox"/> Prototype <input checked="" type="checkbox"/> Pilot
	<input type="checkbox"/> 1st production <input type="checkbox"/> Revision
Comments	
Drawing approved: <i>[Signature]</i> Engineering approved: <i>[Signature]</i>	
Issued by: <i>[Signature]</i>	Date: 3-24-92

TOLERANCES UNLESS SPECIFIED		FRACTION $\pm .010$		DECIMAL $\pm .005$		ANGLE $\pm 1/2^\circ$	
C	CIRCUIT CHANGE	2-20	DR. BY	DATE	MATERIAL		
B	CIRCUIT CHANGE	12-30	A.M.	10-17-91	USED IN		
A	CIRCUIT CHANGE		CH. BY	DATE	No. 27.5		
ISSUE	REVISION	DATE	SCALE	NAME			
				AC-8.5 ASS'Y DWG			
MADRIGAL audio laboratories, inc.				2081 south main street middletown connecticut 06457 u.s.a.			
				SHEET		OF	
				A		B	
				91		91	
				C		D	
				92		92	
				E		R	
				NO.		940781C	



MOUNTING AND ACCESS HOLES
FOR PC BOARD



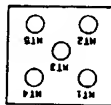
ORIGINAL IN RED
Part: 580186C
Print: 940780C
Release date: 5-22-92
Type of release: ☐ Prototype ☐ Pilot
☒ 1st production ☐ revision
Comments: OK FOR 1st PRODUCTION
Drawing approval: [Signature] Engineering approval: [Signature]
Issued by: [Signature] Date: 5-21-92

TOLERANCES UNLESS SPECIFIED				MATERIAL			
FRACTION ±.010 DECIMAL ±.005 ANGLE ±1/2°				SHEET OF SIZE			
C CIRCUIT CHANGE 2-18				USED IN			
B CIRCUIT CHANGE 12-30				No. 27.5			
A CIRCUIT CHANGE 12-3				NAME			
ISSUE REVISION				DATE SCALE			
				ACB 5			

MADRIGAL audio laboratories, inc.
2001 SOUTH MAIN STREET WILMINGTON CONNECTICUT 06097 U.S.A.

940780C

Page	5801815A
NO	940777A
Package date:	5-14-82
Type of package:	<input type="checkbox"/> Package <input checked="" type="checkbox"/> Unit
Comments:	OK for use as a pattern
On-rolling approved:	On-rolling approved
Inspected by:	Signature: [Signature] Date: 5-14-82

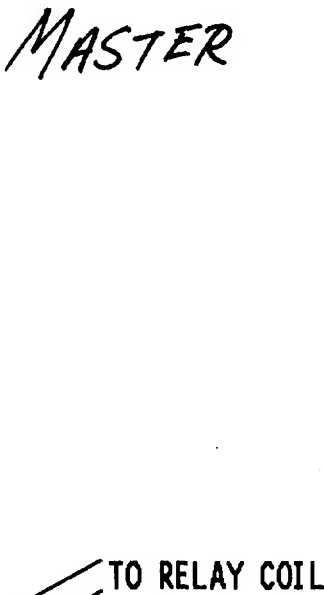


MOUNTING HOLES FOR BOARD

VB-5 TEST PROCEDURE (No.27.5)

- 1) SLOW TURN ON TEST:
 - A) USE +30 VDC
 - B) CONNECT POS (+) LEAD TO P30
 - C) CONNECT NEG (-) LEAD TO P31
 - D) CONNECT RELAY COIL ACROSS P52 AND P53
 - E) TURN ON DC POWER SUPPLY
 - F) RELAY SHOULD ENERGIZE AFTER APPROXIMATELY 1.5 SECONDS

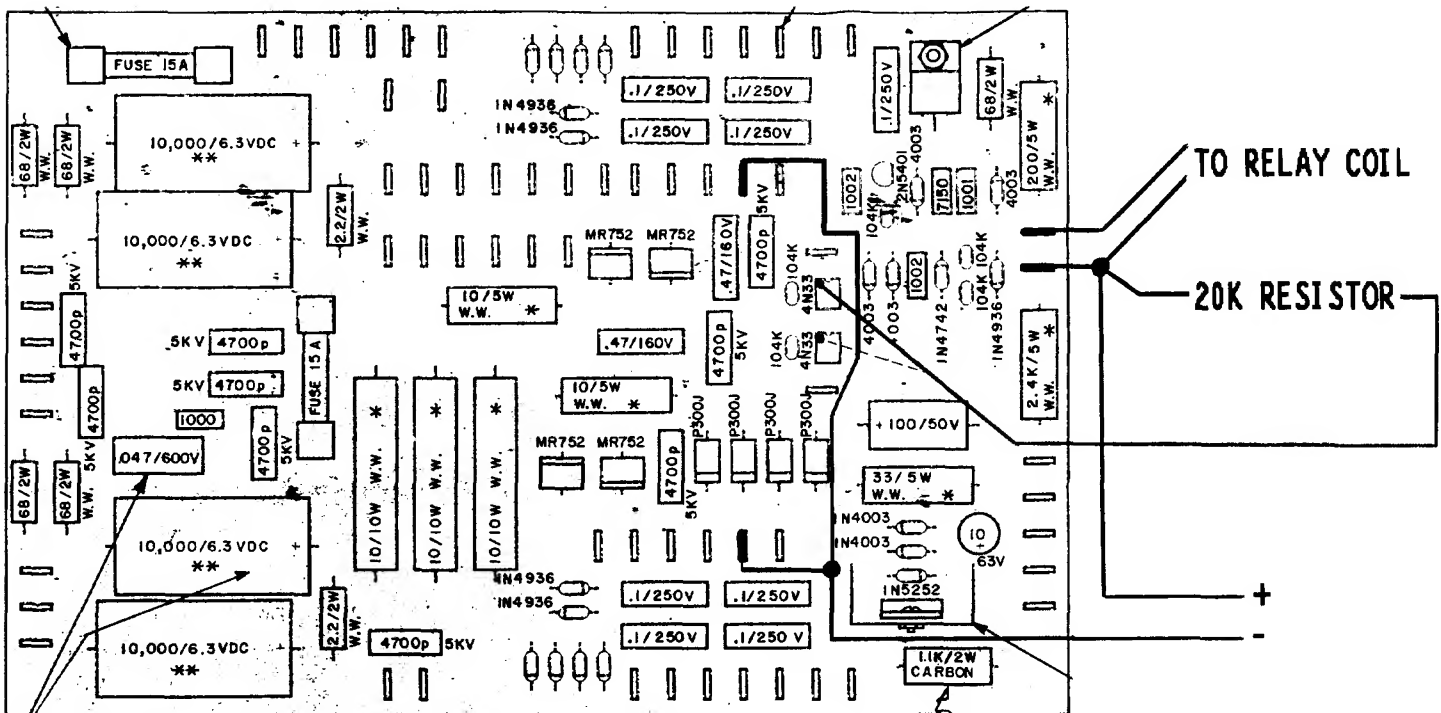
- A) USE +30 VDC
- B) CONNECT POS (+) LEAD TO P30
- C) CONNECT NEG (-) LEAD TO P31
- D) CONNECT RELAY COIL ACROSS P52 AND P53
- E) TURN ON DC POWER SUPPLY
- F) RELAY SHOULD ENERGIZE AFTER APPROXIMATELY 1.5 SECONDS



SLOW TURN ON TEST

2) CIRCUIT PROTECTION TEST:

- A) USE +30 VDC
- B) CONNECT POS (+) LEAD TO P65
- C) CONNECT NEG (-) LEAD TO P36 AND P42
- D) CONNECT RELAY COIL ACROSS P65 AND P66
- E) TURN ON DC POWER SUPPLY
- F) CONNECT 20K RESISTOR ACROSS P65 AND PIN 1 OF EITHER OPTO-COUPLER
- G) RELAY SHOULD ENERGIZE
- H) TURN DC POWER SUPPLY OFF
- I) REPEAT PROCEDURE #2 FOR REMAINING OPTO-COUPLER



CIRCUIT PROTECTION